[0066] The encoder **1409** may be configured to change a resolution of the pattern of the light emitter array **1407** in response to a z-direction distance detected by the distance sensor **1410**. For example, changing the resolution of the pattern may involve turning off at least one light emitter of the array of light emitters and/or grouping at least two light emitters in the array of light emitters to operate together. Further discussion of changing pattern resolution is described in relation to FIG. **11**.

[0067] The devices **1406-1410** may be controlled via the processor **1403** as known in the art. The devices **1406-1410** may be coupled to the processor **1403** and/or other control circuits via digital signal lines, analog signal lines, switching logic, etc. The transmitting device **1402** may include an operating system/firmware **1411** and associated drivers **1412**. The operating system/firmware **1411** and associated drivers **1412** can be used to control various device **1406-1410**, as well as performing some of the functionality. For example, some or all functions of the encoder **1409** can be performed in software.

[0068] In order to facilitate user selection and control of transmitted data, the transmitting device **1402** may include applications **1413** and one or more user interface devices **1414**. The applications **1413** and user interface device **1414** facilitate user selection a variety of data types, content, and functionality associated with the optical transmitter **1406**. The receiving device may have corresponding applications **1433** for receiving, using and/or rendering the content.

[0069] The receiving device **1422** includes an optical receiving device with at least a sensor array **1427** such as a CMOS rolling shutter sensor. A lens assembly **1428** may be used to focus incoming light. A decoder **1429** may be used to decode data in video frames captured by the sensor array **1427**. The devices **1426-1429** may be coupled to the processor **1423** and/or other control circuits via digital signal lines, analog signal lines, switching logic, etc. The receiving device **1422** may include an operating system/firmware **1431** and associated drivers **1432**. The operating system/firmware **1431** and associated drivers **1432** can be used to control various device **1426-1429**, as well as performing some of the functionality. For example, some or all functions of the decoder **1429** can be performed in software.

[0070] In order to facilitate user selection and perception of received data, the receiving device **1422** may include applications **1433** and one or more rendering devices **1434**. The applications **1433** provide a way for user to detect, render, and store data receiving via optical the optical receiving device **1426**. The rendering device **1434** may include any combination of display, speaker, force feedback, haptic feedback, and other perceivable sensation perceived by a user.

[0071] In FIG. **15**, a flowchart illustrates a method according to an example embodiment. The method may optionally involve detecting **1500** at least a z-direction distance between a transmitting device and a receiving sensor array. Data is encoded **1501** into a data signal, and the data signal may optionally be adjusted **1502** based on z-direction distance, if the distance is measured. For example, the signal may be adjusted to decrease a number of bits transmitted per row, and to adjust signals such that some light emitters are turned off and/or two or more emitters are grouped to operate together.

[0072] The data signal is applied **1503** to cause an array of light emitters to illuminate in a pattern at a rate corresponding to a rolling shutter of a receiving sensor array. The array of light emitters is arranged single-file along a y-direction of an emitting surface of a transmitting device. The light is emitted in a z-direction that is normal to the emitting surface. Light is directed **1504** from the array of light emitters through a lens assembly that includes at least one cylindrical lens and at least one aspherical lens. The lens assembly emits light in free-space along the z-direction and has a first focal length in the y-direction and a different, second focal length in an x-direction. The method may optionally involve retrieving **1505** data encoded in the data signal via the receiving sensor array, and rendering **1506** the data to a user.

[0073] In FIG. **16**, a flowchart illustrates a method for encoding data for transmission according to an example embodiment. The method involves determining **1600** a value of N, which corresponds to a number of light emitters in an array. The value of N may be hard coded, and/or determined at run-time, e.g., adjusted if a failed emitter is detected. The value of N may optionally be adjusted **1601** based on a separation distance detected between sending and receiving units. For example, if the light emitter array has 16 light emitters, only eight emitters of the array may be used (or eight groups of two emitters may act together) if it is estimated that the receiving device cannot resolve all 16 emitters.

[0074] The method involves determining **1602** M, which is the number of rows to be transmitted per frame. The value of M may be assumed based on minimum specifications of a receiving device, and may be adjusted based on a separation distance similar to N. In response to a frame synchronization signal **1604**, the next frame of data is obtained **1603** based on N×M. The amount of user data in the frame may be less than N×M, e.g., to account for error correction codes or to account for data structure boundaries.

[0075] From the frame of data obtained at **1603**, a row of data is obtained **1605**. A state vector E is determined **1606** based on the data. For example, an example eight-bit state vector may be expressed as 10000001, and would be result in illuminating only the first and last emitters in the array for the current row R of data. A signal is applied **1607** to the light emitters based on this state vector, and may occur in synchronization with a row sync signal **1608**. The decision blocks **1609** and **1610** cause an iteration to occur through each row in the frame, and through each frame of the data set being transmitted. The decision block **1611** may allow the data set to be repeatedly transmitted. Such repetition may be used to account for transmission errors if data is broadcast (e.g., no way to acknowledge successful receipt of data).

[0076] As previously noted, embodiments described herein may be used in a number of applications, such as billboards, automotive, location beacons, etc. Another application that may use for visible light communication is indoor navigation, which involves recognizing a given light source associated with a location. This can be achieved by transmitting a unique code, e.g., a location code, from a light emitter array. This may be analogous to as bar code, but is actively transmitted by light. The location code need not include an express location value such as latitude/longitude. The location code may be used as an index, e.g., to a table or database, that maps the code to a static or dynamic location.

[0077] The location code of an indoor navigation transmitter can be identified by a receiver within a predefined distance range (e.g., 2-3 m). For example, a user can direct a camera phone at an overhead light which contains a transmitting device as described herein. The transmitter sends a location code, allowing the camera phone to use the location. If this is at a restaurant, for example, this could allow the camera